verging in the east," but the point is apparently below the visible horizon. Shortly after I had, however, the opportunity of seeing the true convergence, as we were crossing the Peasemarsh, a large common near here. It was after rain, and there appeared a very bright spot in the east opposite the true sun, which to the best of my recollection was setting and not set, for I momentarily took the appearance to be some form of reflection of the sun itself. The rays were quite strong in the east and west, and though fainter could be distinctly traced across the sky. I believe that there were no clouds and that the ray intervals were equidistant, though I will not be certain on this point. I notice that one of my drawings also shows this peculiarity, though I confesss my impression has been hitherto that these rays were due to the interference of clouds. J. RAND CAPRON

Guildown, Guildford, Nov. 24

On the Isomerism of Albuminous Bodies

AMONG organic compounds there are large number of bodies hoving the same composition, but different constitution. They are called isomerides. The number of these isomerides increases in proportion as the number of atoms which they contain increases.

Prof. Cayley has already calculated the possible number of isomerides of hydrocarbons. From his result it can be easily seen that the increase of isomerides in proportion to the complexity of the composition is an exceedingly rapid one.

Now the number of atoms which the so-called albuminous bodies contain are very large. The number of isomerides which they can give therefore must be exceedingly large, in fact almost innumerable.

Prof. Schorlemmer, in his "Rise and Development of Organic Chemistry," says: "The enigma of life can only be solved by the synthesis of albuminous compounds." If then these albuminous bodies are really the basis of life, the different species of living beiags must come from innumerable sources, for albuminous bodies have innumerable isomerides. According to this theory, we can say that the different species of living beings, whether animals or plants, were developed out of the chemical compounds having the same composition, but different constitution, but cannot assert, as some do, that they were developed out of the same source, or a few sources

Tokio, Japan, October 12 SHIGETAKÉ SAGIURA

An Extraordinary Lunar Halo

ON Monday evening, November 20, an unusual halo surrounded the moon from 6.15 to 6.25. The moon was not quite full, and the halo to some extent assumed the form of the moon. The halo consisted of a succession of concentric rings. The ring next the moon was equal to four diameters of the moon, and had a soft yellow-white radiance, almost equalling the moon in brilliancy; it was surrounded by a succession of prismatic rings, red commencement, and proceeding outward orange, yellow, green, blue, indigo, and violet. At 6.15 the chromatic rings were pretty sharply defined, with the exception of the outer one, which was faint and evanescent. Outside of the ring was a corona-like envelope. This aspect continued about five minutes, and during the next five minutes rapidly changed; the edges of the rings became irregular, radii shot from the rings towards the moon, and at 6.25 the phenomenon disappeared.

Newcastle-on-Tyne, November 24 J. P. BARKAS

Meteor

A BRIGHT meteor was seen here about 4.30 p.m. in the east. It did not explode, but dissipated itself with scintillations. It reached a very low level before it disappeared.

Oxford, November 27 W. L. HARNETT

Flame in Coal Fire

THE flame referred to by Major Herschel (NATURE, vol. xxvii. p. 78) is simply that of carbon monoxide, which may be observed in most coal fires, after the hydrocarbons are consumed, burning with a pale blue flame. Any yellow tint is of course due to sodium present in the coal. The production of carbon monoxide depends more upon the arrangement of, than the quality of, the coal. Major Herschel will find the reason of its presence give in any text-book on chemistry.

I cannot understand what advantage is obtained by removing the slit of the spectroscope, especially if one wishes to show that a flame is mono-chromatic. When burnt at ordinary pressure, carbon-monoxide has no definite spectrum. SM.

Rugby, November 24

Waterspouts on Land

I AM of opinion that the phenomena referred to by Mr. Hossack are not the effect of waterspouts, but are rather to be attributed to landslips. I may mention a case which may throw some light on the matter. About 1872 (I cannot give the exact date) a landslip occurred on the banks of the Tay, about seven miles north of Dunkeld, close to Guay Station on the Highland Railway, and on the east side of that line. I lived close by at the time, and shortly afterwards saw the effects. Local opinion attributed it to the following causes:—Along the top of the gravelly slope planted with oak and other trees, ran a brook. Immediately above the place where the landslip occurred, the banks of the brook had been burrowed by rabbits. When the sudden flood occurred which caused the landslip, the water of the brook entered these holes, undermined the gravelly slope or terraced beach, and precipitated it across the highway into the field below, devastating fully an acre of it. The trees, turf, &c., were deposited in the field much as they grew upon the slope. I was surprised that they had not been overturned, but it would appear that they had slid down. The effects are still quite visible to passengers on the railway. Had they been photographed at the time, they would have formed a capital illustration for a geological text-book.

Guildhall Offices, Carlisle JOHN GEDDES McINTOSH

NOTES FROM THE LETTERS OF CAPTAIN DAWSON, R.A., IN COMMAND OF THE BRITISH CIRCUMPOLAR EXPEDITION

MAY 21. *On board the s.s. "Nova Scotian."*—A grey sky, a grey foam-flecked sea, floating ice-floes, fog and rain, with a thermometer a few degrees above freezing—such are the features of the Gulf of St. Lawrence this morning, and a cheerful welcome to the New World. Our course has been a long way to the south of Newfoundland on account of the ice, consequently our passage has been a long one. Yesterday was quite lovely, several icebergs were in sight eight or ten miles off, looking like peaks of snow mountains at a distance; now we are in the midst of ice fields delaying us a good deal, as at times it is difficult to find a passage.

May 22. *Quebec.*—We sighted land last night, and saw such a lovely sunset as we went up the St. Lawrence. We have been steaming up the river eighteen hours, but we cannot yet see the land on both sides. We have just passed the *Peruvian*, which left Liverpool a fortnight before us, but she got among the ice and broke her screw, and has been twenty-seven days on the voyage. Another of the Allan line steamers ran into an iceberg. So we feel lucky in getting across without mishap. At the end of the week I start for Winnipeg—2,500 miles by rail—a long journey of five days and four nights.

I find Quebec quite wintry after England; indeed, the snow is still lying in sheltered places where it has drifted, and no trees are in leaf.

June 3. *On Lake Huron.*—On reaching Toronto we went back again into summer—everything was green and spring-like, and the air was quite soft and balmy.

We left Toronto for Sarnia, where we embarked for Duluth, on the west end of Lake Superior—thence it is about twenty-four hours' journey to Winnipeg. Toronto was looking very well. There are groves of horse-chestnut trees in the principal streets, which have a very good effect. At Toronto I was introduced to the Canadian Premier, who took a great interest in my expedition. I also dined with the chief of the observatory there, and they gave me some wine at dinner which was made from their own vines in the suburbs. To Sarnia is about six hours—a most fertile country. The weather, however, is very rainy at present—this is the wet time of the year.

Every train and steamer is full of young Englishmen on their way out to Winnipeg, where they expect to make their fortunes, and no doubt it is a great place to make money just now.

We were two days running up Lake Huron, for the most part out of sight of land, and the land we did see was flat and ugly, till in the evening of the second day we reached the river joining the two lakes (Lake Huron and Lake Superior), and anchored at Sault St. Marie for the night. The river runs between rocky pine-covered shores, and in the evening we had one of those sunsets one only seems to see in this country—a blood-red sky overhead, orange at the horizon, with the pine woods rising black against it, and the broad reaches of the river winding away westward, all a blaze of golden light—just the subject for Turner.

The next morning we went through a lock into Lake Superior, and twenty-six hours' run took us to Thunder Bay, a barren looking place. Hard by is Thunder Cape, a bold headland 1,300 feet high. The water of Lake Superior never rises more than two or three degrees above freezing-point, and in old days it would certainly have been thought an enchanted lake, so strange are the effects of the mirage. At one moment you see a long line of cliffs, a minute later they have turned into a reef of rocks hardly above the water, or a little table-topped mountain on the horizon suddenly splits into two sharp peaks, and anon takes the shape of an hour-glass.

June 8. *Winnipeg.*—When we awoke this morning we were on the prairies—just like the sea, only grass instead of water—a green plain losing itself in the far horizon. The journey along the Northern Pacific Railway, from Duluth, by the side of the rapid river St. Louis was lovely.

Winnipeg is a flourishing place with 20,000 inhabitants, where a few years ago there was nothing but a few huts. It stands on the Red River of the north—a fine river about the size of the Rhine. All the people here are Cree Indians, who speak their language and don't understand English, but they are dressed in European dress, so they look more like gipsies than anything else.

June 27. *Fort Carlton.*—We arrived here yesterday, such lovely country, like an English park, with wild roses and other flowers growing in great profusion. The river rather reminds me of the Thames at Richmond. The Saskatchewan is a magnificent stream, far larger than the Red River, flowing between pine forests. The weather is simply perfect, except that the sun is rather hot in the middle of the day. The fare is rather rough. No milk or fresh bread—chiefly fish, biscuit, and salt meat. It was slow work getting up the rapids. A boat with a crew of Indians takes out a hawser a mile long, which is made fast to a tree above the rapids, then the other end is brought down to the steamer, and fastened to the capstan, and we slowly drag ourselves up. The steamer is propelled by an enormous paddle wheel at her stern, and at the bow is a great arrangement of spars for lifting her off sandbanks, should she run aground; and though she carried 150 tons of cargo she only drew three feet of water.

On the 23rd we reached the Forks of the Saskatchewan, where the river divides; we took the northern branch and warped up the rapids to the settlement of "Prince Albert," where the country looks quite like England. Land is to be had here for 2 dollars or 8*s*. an acre, and it seems wonderfully fertile—the soil looks so rich. It is certainly the place I should recommend any enterprising emigrant to come to if he only has a little capital to start with—300*l*. would be plenty. The soil wants no clearing; you have only to build a house and plough and sow your land. The climate is one of the finest in the world. I was talking to a retired officer of the 50th who has been here seven years, who says he has never had an hour's illness, and feels as though he were growing younger every year.

Fort Carlton is the *beau idéal* of a Hudson's Bay fort, with a stockade twenty feet high and towers at the corners. But the days when the Blackfeet made their raids are over, and the Cree or Ojibbeway Indians, whose "lodges" one sees all around, are very pacific. A great many speak a little French, but no English.

July 14. *Ile à la Crosse.*—We left Carlton on the 30th, *i.e.* my own party and two missionaries. I had a train of ten Red River carts drawn by horses and oxen. I drove in a light American waggon. The scenery was at first like English country, only without hedges. There was plenty of deep grass and vetches, which afforded splendid fodder for the animals. There were quantities of snipe, duck, and prairie chicken. The land was gay with wild flowers; orange-lilies were most conspicuous, and lots of wild strawberries. The mosquitoes were the only drawback, at times forcing us to wear veils and gloves, and to eat our meals in the smoke of our camp fires. After three days we reached a hill, from whence we saw the great sub-arctic forest stretching away like a sea to the north. It extends nearly to the Arctic Circle, and from the Atlantic to the Pacific.

On the 9th we reached Green Lake, but it blew so hard that we did not start till the 11th. Our conveyance was a Hudson's Bay Company's inland boat; our crew was of Crees and Chipewyans. The latter speak a language like the ancient Mexicans, quite unlike any other I have heard; it is like the noise of a person choking. It takes years to learn even a smattering of it. We drifted down the stream all night, our boats being lashed together, and we slept as best we could in the bottom of them.

Ile à la Crosse is on an island in the middle of a lake, and is comparatively free from mosquitoes. I had a splendid boat's crew—seven oars and a steersman; we pulled nearly fifty miles the first day. We rested on Sunday, and the day after crossed Buffalo Lake most fortunately—a fair wind sprang up just in time to take us across, as it cannot be crossed against the wind. Then we began to ascend the Rivière la Loche, which took us all the next day, there being two portages or places where the contents of the boats and sometimes the boats themselves have to be taken overland. Thence we entered Methy Lake, about thirty miles long at the north, and a narrow creek took us to the beginning of Portage la Loche, or the Long Portage, which is a road some twelve or fourteen miles long, leading to the Clear Water River which flows into the Athabasca and ultimately into the Mackenzie, so we are on the Arctic Slope at last.

July 22. *Portage la Loche.*—I rode over last night in company with the Hudson's Bay Company's officer in charge of the post. The road leads through pine woods, and passes a pretty lake, and ultimately descends a hill of about 400 feet into this valley. I am writing this in my tent, pitched on the bank of the Clear Water River, which flows past about three yards off. Across the river are wooded hills 600 feet high; to the left the river disappears among the pine woods in a dark ravine; to the right it winds away in the distance among blue hills. It is all so green and pretty that it is difficult to believe that in a few months all will be ice and snow. All the last week the heat has been intense, the thermometer over 86° in the shade all day. This morning we saw a bear prowling about opposite. We are now among the Chipewyan Indians; they are very different from the Crees; in appearance they remind me a little of drawings of the Esquimaux, with round greasy faces. About here they are mostly Roman Catholics, as there is a large mission at Ile à la Crosse.

The best description of this country in general is by saying that it is like Switzerland without mountains, but with big rivers and lakes. The plants are much the same, and the climate is much the same. The trees are very fine, and, as elsewhere, strawberries, raspberries, cranberries, black and red currants, and gooseberries grow wild.

There is a fine view down the valley from the top of the hill; it was mentioned by Sir J. Frankland, who has been through all this country.

July 24.—The Athabasca boats arrived last night, so we are off this morning.

ON THE GRADUATION OF GALVANOMETERS FOR THE MEASUREMENT OF CURRENTS AND POTENTIALS IN ABSOLUTE MEASURE[1]

II.

In the preceding investigation nothing has been said as to the units in which the quantities m and H are measured. It will be convenient, before proceeding further, to consider shortly the measurement of magnetic and electrical quantities in absolute units, and particularly the centimetre, gramme, second (c.g s.) system now generally adopted.

According to what is called the electro-magnetic system, all magnetic and electrical quantities are measured by units which are derived from a magnetic pole chosen as the pole of unit strength. This pole might be defined in many ways; but in order to avoid the fluctuations to which most arbitrary standards would be subject, and to give a convenient system in which work done in the displacements of magnets or conductors, relatively to magnets or to conductors carrying currents, may be estimated without the introduction of arbitrary and inconvenient numerical factors, it is connected by definition with the absolute unit of force. It is defined as *that pole which, if placed at unit distance from an equal and similar pole, would be repelled with unit force.* The poles referred to in this definition are purely ideal, for we cannot separate one pole of a magnet from the opposite pole of the same magnet: but we can by proper arrangements obtain an approximate realisation of the definition. Suppose we have two long, thin, straight, steel bars, which are uniformly and longitudinally magnetised; their poles may be taken as at their extremities; in fact, the distribution of magnetism in them is such that the magnetic effect of either bar, at all points external to its own substance, would be perfectly represented by a certain quantity of one kind of imaginary magnetic matter placed at one extremity of the bar, and an equal quantity of the opposite kind of matter placed at the other extremity. We may imagine, then, these two bars placed with their lengths in one line, and their blue poles turned towards one another, and at unit distance apart. If their lengths be very great compared with this unit distance, say 100 or 1000 times as great, their red poles will have no effect on the blue poles comparable with the repulsive action of these on one another. But there will be an inductive action between the two blue poles which will tend to diminish their mutual repulsive force, and this we cannot in practice get rid of. The magnitude of this inductive effect is, however, less for hard steel than for soft steel, and we may therefore imagine the steel of our magnets so hard that the action of one on the other does not appreciably affect the distribution of magnetism in either. If, then, the two blue poles repel one another with a unit of force, each according to the definition has unit strength.

The magnitude of unit pole is by the above definition made to depend on unit force. Now unit force is defined, according to the system of measurement of forces founded on Newton's Second Law of Motion, the most convenient system, as that force which, acting for unit of time on unit of mass, will give to that mass unit of velocity. Our unit pole is thus based on the three fundamental units of length, mass, and time. According to the recommendations of the B.A. Committee, and the resolutions of the Paris Congress, it has been resolved to adopt generally the three fundamental units already in very extended use for the expression of dynamical, electrical, and magnetic quantities, namely, the centimetre as unit of length, the gramme as unit of mass, and the second as unit of time. With these units, therefore, the unit force is that force which, acting for one second on a gramme of matter, generates a velocity of one centimetre per second. *This unit of force has been called a dyne.* The unit magnetic pole, therefore, in the c.g.s. system of units is that pole which, placed at a distance of 1 centimetre from an equal and similar pole, is repelled with a force of 1 dyne. Each of the poles of the long thin magnets of our example above is therefore a pole of strength equal to one c.g.s. unit, if the mutual force between the poles is 1 dyne.

The magnetic moment m of anyone of the deflecting magnets is equal to the strength of either pole multiplied into the distance between them, which for magnets of such great length in comparison with their thickness is nearly enough the actual length of the magnet. Therefore either pole has a strength of $\frac{m}{2l}$ units. If r and l are measured in centimetres, and W in grammes, the strengths of the magnetic poles deduced from equation (4) or (6) will be in c.g.s. units.

A magnetic field is the space surrounding a magnet or a system of magnets, or a system of conductors carrying currents, at any point of which, if a magnetic pole were placed, it would be acted on by force. From the definition of unit magnetic pole we get at once the definition of magnetic field of unit intensity. *Unit magnetic field is that field in which unit magnetic pole is acted on by unit force*, and in the c.g.s. system, therefore, it is that field in which unit magnetic pole is acted on by a force of one dyne. In the theory of the determination of H, given above, the horizontal force on either pole of the needle due to the horizontal component of the earth's field is taken as $\frac{m'}{2l'}.H$, and again the horizontal force on either pole of the deflecting magnet as $\frac{m}{2l}.H$. H is, therefore, the strength in units of magnetic field intensity of the horizontal component of the earth's field. By formula (5) or (7), when r and l are taken in centimetres, and W in grammes, H is given in dynes; that is, it is the number of dynes with which a unit red pole would be pulled towards the north, and a unit blue pole towards the south if acted on only by the earth's magnetic field. We can now go on to the measurement of currents.

According to the theory of electro-magnetic action given by Ampère, every element of a conductor in which a current is flowing acts upon a magnetic pole with a force which varies inversely as the square of the length of the line joining the centre of the element with the pole, and directly as the strength of the current and as the length of the projection of the element on a plane at right angles to that line. The direction of this force is at right angles to a plane drawn through the pole and the element, and acts towards one side or the other of that plane, according as the current in the element is in one or the opposite direction, and according as the magnetism of the pole is red or blue. From this it is easy to obtain a definition of unit current in the electro-magnetic system. It is that current which, flowing in a wire of unit length bent into an arc of a circle of unit radius, acts on a unit magnetic pole placed at the centre of the circle with unit force. Thus the current of unit strength in the complete circle of unit radius would act on a unit pole at the centre with 2π units of force, in the c.g.s. system with 2π dynes. This force acts towards one side or the other of the plane of the circle, according to the nature of the pole and the direction of the current. If the current, considered as flowing from the copper plate to the zinc plate of a Daniell's cell, were made to circulate round the face of a watch in the direction opposite to that in which the hands move, a red pole placed at

[1] Continued from p. 35.